Stabilised Finite Element for high Reynolds number, LES and free surface flow problems.

T. Coupez, G. François, E. Hachem

CIM, CEMEF - Mines Paristech
1 rue Claude Daunesse, 06904 Sophia Antipolis, France
thierry.coupez@mines-paristech.fr

A recently developed stabilised finite element method which draws upon features of both mixed and stabilized finite element methods is generalised for the incompressible Navier–Stokes equations for high Reynolds numbers and free surface flows problems. The proposed method start with a stable mixed formulation made of continuous piecewise linear functions enriched with a bubble function for the velocity and piecewise linear functions for the pressure. This choice of elements is stable at low Reynolds number, when the Stokes flow is dominant. However, for simulating high Reynolds number, an extension of this method based on the multiscale approach is then applied. It is shown that the formulation is able to model a wide range of both 2D and 3D high Reynolds number flow conditions.

On the other hand, the main challenge remains in solving the turbulent two-phase flows which occurs in a wide range of real life problems, industrial processes including molten metal flow, sloshing in tanks, wave mechanics, flows around structure. A successful approach to deal with such flows, especially in the presence of turbulent chaotic behaviour is the use of a local convected level set method coupled to a Large Eddy Simulation method. The last feature of the proposed algorithm is the use of a modified dynamic method in order to reduce the numerical dissipation, to limit the eddy viscosity overestimation and to take into account the multi-fluid characteristics.

We assess the behaviour and accuracy of the proposed mixed-stable method coupled to the two-phase turbulent approximation in the simulation of complex 3D flows, such as the flow in a partially-filled two communicating tanks. Results are compared with the experimental data and show that the present implementation is able to exhibit good stability and accuracy properties for high Reynolds number flows using unstructured meshes.

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